of norepinephrine or other pressor therapy, and bradycardia has resolved with either atropine or calcium administration.

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Pneumatic Antishock Trousers

THE USE OF DEVICES producing external counterpressure on the lower extremities and abdomen has become widespread since the dissemination of reports documenting their efficacy in controlling hemorrhage and hypervolemic shock during the Vietnam War. Military antishock trousers (MAST) were used most commonly with injuries to the lower extremities, pelvis and abdomen. Many subsequent reports have verified the device's effectiveness in similar types of trauma in civilians. External counterpressure is particularly beneficial in stabilizing patients with pelvic and lower extremity fractures; not only are the fractures splinted, but the bleeding sites about the injured area are tamponaded by the inflated garment, preventing excessive blood loss.

Hypotension due to volume maldistribution, such as in spinal cord trauma, drug effects or dysfunction of the sympathetic nervous system (as in autonomic neuropathies), will also often respond to the application of pneumatic trousers. Recent data suggest as well that abdominal binding, such as that produced by pneumatic trousers, can improve the efficacy of cardiopulmonary resuscitation during external cardiac massage. The probable mechanism for the increase in systolic blood pressure and carotid blood flow seen after MAST application is increased intrathoracic pressure during chest compression due to limitation of diaphragmatic descent by abdominal binding.

External counterpressure produces a number of physiologic effects in addition to tamponade of external and internal bleeding sites located under the garment. These include increased central venous pressure, increased peripheral vascular resistance, mild lactic acidosis (with prolonged inflation), clinically insignificant effects on renal and pulmonary function and increased carotid blood flow. Although "autotransfusion" of about a liter of blood from the lower extremities and abdomen to organs above the diaphragm was once thought to occur, recent data have shown no increase in cardiac output, stroke volume or pulmonary diffusing capacity, corresponding to the earlier findings of Tenney and Honig during ballistocardiography. This suggests that the intravascular transfer produced by the device is minimal, at most only 250 to 300 ml. Mechanisms other than autotransfusion, such as increased afterload produced by compression of vasculature in areas covered by the trousers, are a more likely basis of their effectiveness in the treatment of hypotension.

Contraindications to the use of antishock trousers include congestive heart failure and pulmonary edema, as increased preload and afterload produced by inflation may worsen these conditions. Pregnant women should not have the abdominal compartment inflated because of risk to the fetus. Use of MAST with injuries or known bleeding sites above the diaphragm remains controversial because redistribution of blood flow to a nontamponaded area may lead to increased blood loss, while circulation to vital organs such as the heart and brain may be increased. Profound hypotension has been seen after rapid deflation of the antishock trousers, probably resulting from reactive vasodilatation in areas previously compressed. Deflation should always be gradual and well monitored, with only one compartment depressurized at a time. In the event of a dramatic fall in blood pressure during deflation, the suit should be reinflated appropriately and fluid infusion continued. If surgical treatment is indicated, deflation of the garment should take place in the operating room only after anesthesia is induced and the surgical team is prepared to operate.

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Overdose Update—Diminishing Drug Absorption

EMERGENCY PHYSICIANS have empirically used a variety of techniques to lessen gastrointestinal absorption of poisons; unfortunately, the efficacy of such techniques has not been subjected until recently to careful analysis. Newer studies should provide us with a more systematic and rational approach to poisoned patients.

General supportive care, combined with attention to and protection of the airway, remains the most critical aspect in the treatment of most cases of poisoning or overdose. Initial efforts at diminishing the total drug burden can be significantly valuable, however. Ipecac-induced emesis removes a greater amount of material than lavage and is preferable unless there is altered mental status or decreased gag reflex. Both are contraindicated in caustic ingestions, and may be inappropriate in hydrocarbon ingestion. Ipecac syrup is virtually nontoxic when used in standard doses. Its use is effective in 95 percent of patients, including those who have overdosed on antiemetics. There is no evidence that emesis is facilitated by having a patient drink large quantities of water; significant dilution may actually encourage greater absorption, as well as moving the drug into the small bowel where it is not amenable to either emesis or lavage. Carbonated beverages apparently do not diminish the effectiveness of ipecac, and in treating children may increase its palatability.

Activated charcoal has been shown in experimental overdose situations to significantly decrease drug con-

centrations and to favorably affect outcome. Charcoal should be used in virtually all overdose cases; most tested chemicals and drugs are adsorbed, and there are few contraindications. Charcoal should be avoided if it adsorbs an orally given antidote used in a specific poisoning. Adsorption of orally administered acetylcysteine by charcoal has been suggested in one study, but was seemingly absent in another. Until this is clarified activated charcoal should probably be withheld in major acetaminophen overdoses. Likewise, charcoal will adsorb orally administered ethanol, and thus should be withheld in methanol and ethylene glycol overdose.

Charcoal palatability can be increased by the addition of sorbitol or saccharin, the latter of which can be used in a 1:20 dilution and thus not increase total volume of charcoal that has to be swallowed.

Cathartics have not been proved to be beneficial in overdose cases, but recent studies show that at least in some cases they actually increase the adsorptive capacity of charcoal. Magnesium cathartics, in particular, increase cathartic removal of salicylates and several other substances.

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Coelenterate (Man-of-War) Envenomation

RECREATIONAL AND INDUSTRIAL PURSUITS in coastal tropical waters have increased the number of envenomations inflicted by coelenterates (cnidarians) on humans. The most frequent offenders are *Physalia physalis,* the Atlantic Portuguese man-of-war, and *Physalia utriculus* (bluebottle), the Pacific version. These predators are free-swimming, pelagic organisms composed of a nitrogen and carbon monoxide-filled sail (pneumatophore) up to 30 cm long from which are suspended nematocyst (venom organelle)-laden tentacles. These tentacles may be numerous and measure up to 30 m (100 ft) in length *(P physalis).* When the animal moves in the ocean, these structures coil and fold to produce stinging "batteries," which may involve more than a million nematocyts.

Nematocyst venom includes toxic fractions that can invoke any and all of anaphylaxis, muscle spasm, exquisite pain and neurologic-cardiovascular collapse. Venom components include adenosinetriphosphatase, fibrinolysin, hyaluronidase, histamine, peripheral calcium antagonists, myocardial depressants, hemolysins and dermatonecrotic agents. Milder envenomation may provoke only an irritant dermatitis, whereas severe stings may induce generalized multisystem failure.

The immediate therapy for coelenterate stings is gentle topical application of isopropyl alcohol (40 percent) or acetic acid (5 percent). Fresh water or abrasion will discharge unexploded nematocysts and should be avoided. Following the initial detoxification, the remaining organelles can be removed by shaving the affected area. All patients should receive appropriate tetanus prophylaxis. Muscle spasm and pain are controlled with the administration of calcium gluconate and narcotics, respectively. Severe envenomations may require advanced life support. Washed-up tentacle fragments can retain activity for months. In children who ingest these, acute airway obstruction may develop from local oropharyngeal edema. Prompt detoxification and airway management is often lifesaving. Steroid administation has not been shown to be of definitive benefit.

There is not yet an effective antivenin for the sting of *Physalia,* as there is for *Chironex fleckeri* (box-jelly or sea wasp). The increased incidence of envenomations has provided impetus for a growing interest in the development of such an agent.

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Mechanism of Blood Flow During Cardiopulmonary Resuscitation

CARDIOPULMONARY RESUSCITATION (CPR) is a therapeutic method that over the past 20 years has proved to be the critical first component in the management of sudden cardiac death. New concepts and controversies have recently been generated regarding the mechanism of blood flow during CPR: The central issue and major controversy is whether blood flow results from compression of the heart between the sternum and spine, as initially espoused by Kouwenhoven and colleagues, or whether antegrade flow is primarily due to the generalized rise in intrathoracic pressure that occurs during the act of chest compression, as suggested by animal and human investigations at Johns Hopkins University, the University of California, the Baylor College of Medicine and the University of Washington.

According to the latter theory, blood flow during CPR results from rhythmic increases in intrathoracic pressure during chest compression. The increase in intrathoracic pressure is transmitted directly to the extrathoracic arterial bed but, due to closure of venous valves, not to the peripheral venous system. A peripheral arterial-to-venous perfusion gradient is thus established that facilitates blood flow. This theory is supported by the finding that pressures in the cardiac chambers and ascending aorta rise to a level equal to the change in intrapleural pressure during chest compression. (If selective cardiac compression were to occur, ventricular pressures would exceed atrial pressures). In addition, cineangiographic studies in animals and two-dimensional echocardiographic studies in hu-